PRACTITIONER'S HAND BOOK

DESIGNED TO ACCOMPANY

PHYSICIANS' ANATOMICAL AID

PREPARED BY

D. W. GRAHAM, A.M., M.D.

AND

J. SUYDAM KNOX, A.M., M.D.

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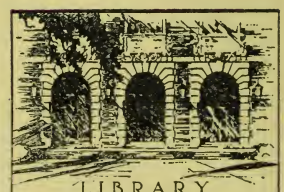

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Physician's Anatomical Aid

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PART FIRST

THE SKELETON—BLOOD FORMATION AND CIRCULATION—NERVOUS SYSTEM—SECTIONS OF THE BODY AND ITS EXTREMITIES—STRUCTURE OF HEAD, EYE AND EAR.

BY

D. W. GRAHAM, A.M., M.D.,

Professor of Surgery, Woman's Medical College,
Surgeon Cook County Hospital.
Surgeon Presbyterian Hospital.
CHICAGO

TABLE OF CONTENTS.

PART FIRST.

THE SKELETON.

BLOOD FORMATION AND CIRCULATION.

NERVOUS SYSTEM.

THE BODY AND EXTREMITIES.

THE HEAD.

PART SECOND.

THE MALE GENERATIVE ORGANS.

THE FEMALE GENERATIVE ORGANS.

Letters and figures enclosed in parenthesis, in this Hand Book, refer to parts or organs similarly lettered or numbered on sections or plates.

THE SKELETON.

INDEX TO PLATE.

(1).—Frontal.
(2).—Parietal.
(3).—Temporal.
(4).—Mastoid part of Temporal.
(5).—Nasal.
(6).—Malar.
(7).—Superior Maxillary.
(8).—Teeth.
(9).—Inferior Maxillary.
(10).—Cervical Vertebrae.
(11).—Dorsal Vertebrae.
(12).—Lumbar Vertebrae.
(13).—Clavicle.
(14).—Scapula.
(15).—Sternum.
- (A). Manubrium.
- (B). Gladiolus.
- (C). Ensiform Appendix.

(16).—True Ribs.
(17).—False Ribs.
(18).—Floating Ribs.
(19).—Humerus.

(20).—Radius.
(21).—Ulna.
(22).—Carpus.
(A). Scaphoid.
(B). Semi-lunar.
(C). Cuneiform.
(D). Pisiform.
(E). Trapezium.
(F). Trapezoid.
(G). Os Magnum.
(H). Unciform.
(23).—Metacarpus.
(24).—Phalanges.
(25).—Sacrum.
(26).—Coccyx.
(27).—Ilium.
(28).—Ischium.
(29).—Pubes.
(30).—Head of Femur.
(31).—Neck of Femur.
(32).—Shaft of Femur.
(33).—Patella.
(34).—Tibia.
(35).—Fibula.
(36).—Tarsus.
(A). Os Calcis.
(B). Astragalus.
(C). Scaphoid.
(D). Head of Astragalus.
(E). Internal Cuneiform.
(F). Middle Cuneiform.
(G). External Cuneiferm.
(H). Cuboid.
(37).—Metatarsus.
(38).—Phalanges.

THE SKELETON.

The skeleton consists of two hundred bones excluding those of the ear and the smaller sesamoid bones. The sacrum and coccyx, together, have the elements of nine vertebrae, but are counted as two bones. The bones give outline to the body and support to the soft parts, form cavities for the protection of the important organs and serve as levers and points of attachment for muscles in locomotion, and motion of individual parts.

As to their form, bones are classed as long, short, flat, and irregular.

Long bones have three sources of arterial supply: the periosteal vessels for the compact tissue of the shaft; the nutrient or medullary artery for the marrow and deeper parts of the shaft; the articular arteries for the cancellous tissue and red marrow of the extremities. These sets of vessels communicate freely with each other.

In structure, bone tissue is either dense or porous. The former is *compact tissue*, and is found in the shaft of the long bones and the surfaces of all bones; the latter is *cancellous tissue*, and forms the expanded ends of the long bones and the central part of other bones. Compact tissue is disposed in concentric layers (*lamellae*). Cancellous tissue is made by these layers separating, diverging and interlacing, the fibres being disposed in the forms of arches, which give elasticity and strength. These arches are always arranged with reference to points of pressure and traction.

Except where covered with cartilage, bones are surrounded by a dense fibrous membrane, the *periosteum*, which serves as a nidus for the subdivision and distribution of arteries to the bone beneath. It sends a sheath with each vessel. By its under layer, which is gelatinous and contains the osteoblasts, it contributes to the growth, nutrition, and repair of bones.

Histologically, bone consists of bone spaces with their contents, and the bone tissue proper. The spaces are the *medullary cavities*, the *Haversian canals*, the *lacunae*, and the *canaliculi*. The medullary cavities are the canals of long bones which contain yellow marrow (ninety-eight per cent. fat), and the medullary cavities of the cancellous tissue, which contain red marrow, which substance contributes to the formation of the red blood corpuscles. The medullary membrane (*endosteum*) lines these canals and spaces.

The Haversian canals average 1-500th of an inch in diameter. The larger ones contain marrow, and all convey one or more blood vessels. The lacunae are characteristic of true bone, as distinguished from calcareous deposits. They are insect-like cavities, between the lamellae, arranged in circles around the Haversian canals, oval-shaped, and in size 1-2000th by 1-6000th of an inch. Each one contains a soft, nucleated substance called a "bone corpuscle." The canaliculi are the channels by which the lacunae communicate with each other and with the Haversian canals. Diameter 1-14000th of an inch and less. They contain, each, a minute

process of the "bone corpuscle" of the lacunae. This process imbibes nutrient fluid from the blood in the Haversian canals and passes it on from one lacuna or "bone corpuscle" to another—thus supplying the bone tissue with nutrient material.

Bone tissue, proper, occupies all the space between the lacunae and canaliculi. It is one-third organic and two-thirds earthy matter. The organic matter makes the outline and forms a bed in which the earthy matter is laid down as minute osseous granules.

The embryonic skeleton consists, at first, entirely of this animal matrix, for the most part in the form of hyaline cartilage.

Ossification begins by a deposit of bone granules in the matrix, at certain points. Each point is a "center of ossification." These centers are definite in number and in their order of succession for each bone, but vary in different bones.

The skeleton begins to ossify in the clavicle, by a center which appears the middle of the second month of foetal life.

The primary center in a long bone is for the shaft (diaphysis). After the shaft is well advanced in ossification, secondary centers (epiphyses) appear in the articular ends of the bone. Still later, other centers appear for the processes, tuberosities, etc.

The first epiphysis to appear, and the only one present at birth, is that of the lower end of the femur. This fact is available in determining certain medico-legal questions about premature birth.

Soon the diaphysis is separated from its epiphyses. only by a thin disc of cartilage (epiphyseal cartilage). Eventually, they unite and become continuous by ossification of the disc, when the individual has attained full stature. This process is completed in all long bones by the twenty-fifth year.

Of the epiphyses, that one which appears first unites last. The nutrient artery runs toward that epiphysis which unites first. The nutrient arteries run *toward* the elbow in the upper extremity, but *from* the knee in the lower limb.

Bones derive their growth in length from the epiphyseal cartilages, but not in equal degree from the upper and lower. That epiphysis which appears first—being the one from which the nutrient artery runs—contributes most to the growth in length. Hence, in the upper extremity, the growth in length is derived mostly from the epiphyses at the shoulder and wrist, while in the lower limb those at the knee contribute most.

Growth in length is arrested if an epiphyseal cartilage is destroyed by suppuration, or prematurely ossified by inflammation. The amount of the permanent shortening of the limb resulting, will depend on which cartilage is involved, and whether its destruction has been complete or partial; and if partial, whether on the epiphyseal or diaphyseal face of the cartilage; for that surface of the cartilage toward the diaphysis contributes about fifteen times more to the growth in length than does the epiphyseal face.

The epiphyseal cartilage, to a certain extent,

serves as a barrier to the extension of inflammation and suppuration from one part to the other.

The expanded part of the shaft, between the end of the medullary canal and the epiphyseal cartilage, is called the juxta-epiphyseal portion (Ollier), and from a pathological and surgical standpoint is the most important part of the bone. It is the seat of the greatest physiological activity and prolification, and is the zone of election for all pathological processes. Also, on account of its close relation to a joint, and exposed position, it is most liable to over-strain, local fatigue, and other slight traumatisms. Whence the explanation of the fact that the juxta-epiphyseal portion of long bones, and to some extent the corresponding part of other bones, is much the most frequent point of departure for inflammations and development of neoplasms during the period of growth. Also, at this period, that end of the bone which contributes most to its growth in length, is the seat of election for neoplasm and inflammatory lesions. Hence, the more frequent appearance of benign and malignant growths in the epiphyses at the shoulder, wrist and knee, than in those at the elbow, hip and ankle. So with all the inflammatory processes, tubercular, or other kind. Though, on account of certain joints being more exposed to traumatisms, the rule is not as invariable for inflammatory processes as for neoplasms.

BLOOD FORMATION AND CIRCULATION.

(*Semi-diagrammatic.*)

INDEX TO PLATE.

ARTERIES.

(1).—Carotid Arteries which, with the vertebral, supply the head.

(2).—Innominate Artery.

(3).—Sub-clavian.

(4) (4) (4).—Arch of the Aorta—ascending, transverse and descending portion.

(5) (5).—Pulmonary Arteries, right and left, containing venous blood.

(6).—Thoracic Aorta.

(7) (8) (9).—Gastric, Hepatic and Splenic—branches of the Coeliac Axis, which is a branch of

(10).—Abdominal Aorta.

(11).—Superior Mesenteric—to small intestines and part of large.

(12).—Renal.

VEINS.

(13).—Vena Cava Superior.

(14) (14).—Innominate—right and left.

(15).—Sub-clavian.

(16).—Jugular.

(17).—Pulmonary—containing arterial blood.

(18).—Vena Cava Inferior.
(19).—Hepatic.
(20).—Gastric.
(21).—Splenic.
(22).—Mesenteric.
(23).—Vena Portae.
(24).—Renal (emulgent).
(25).—Right Auricle.
(26).—Left Auricle.
(27).—Right Ventricle.
(28).—Left Ventricle.
(29).—Thoracic Duct.

VISCERA AND LYMPHATICS.

(30).—Stomach.
(31).—Spleen.
(32).—Liver.
(33).—Kidney.
(34).—Duodenum.
(35).—Ascending Colon.
(36).—Descending Colon.
(37).—Lymphatics of the Intestines—the vessels being called Lacteals; the glands the Mesenteric Glands.

THE CIRCULATION.

The *greater* or *Systemic Circulation* includes the course of the blood from the left auricle (26) through the left ventricle (28), arch of the aorta (4), the arteries to the upper extremities (3), those to the head (1), thoracic aorta (6) and its branches, abdominal aorta (10) with its branches, and its

continuation and sub-divisions for the lower extremities; together with the capillaries and veins corresponding to the areas of distribution of the arteries—the veins from the head and upper extremities joining to form the superior vena cava (13),which opens into the right auricle—those from the lower extremities and the pelvic and abdominal viscera join to form the inferior vena cava (18), which also opens into the right auricle.

The blood from the intestines and digestive organs passes through a second set of capillaries, in the liver, before joining the general current in the vena cava.

The *Portal Circulation*—a part of the Systemic —includes the course of the venous blood from all the organs of digestion, through the superior and inferior mesenteric veins and the splenic and gastric veins, which four trunks join to form the *portal* vein (23). This vein is about four inches long and extends from behind the head of the pancreas to the transverse fissure of the liver, where it sub-divides, and the blood, after passing through a second set of capillaries in the liver, leaves it through the *hepatic* veins and empties into the vena cava inferior. The portal system of veins has no valves.

The *lesser* or *Pulmonic Circulation* includes the course of the blood from the right auricle (25) through the right ventricle (27), through the pulmonary arteries (5, 5), to the lungs, and its return through the pulmonary veins (17), with a fresh supply of oxygen, to be again distributed throughout the system.

The Lymphatic System is an appendix of the Vascular System. Lymphatic vessels begin in the tissues as "lymph spaces" in connective tissue, as "perivascular spaces," and as blind tubules within the villi of mucous membrane. These spaces, or canals, unite to form tubes which unite again and converge to form the *thoracic duct* and the *right lymphatic duct*. In their course, they pass through (rather empty into and begin anew) numerous lymphatic glands, which are a collection of lymph follicles, and are of the size of a pin head and larger. In structure, these vessels resemble veins and have many valves. The functions of the lymphatic system are, to serve as nutrient channels in those tissues devoid of blood-vessels; as a drainage apparatus to collect and return to the blood fluids which have oozed through the capillaries to irrigate the tissues; and as absorbents and carriers of both waste products and food products. The lymphatics from the intestines are the *lacteals*, and during digestion, their contents are called *chyme*. The lymph current is from the periphery to the center only.

The *blood* is the medium of exchange between the outer world and the tissues of the body. It conveys tissue building materials from without—food products from the digestive tract, and oxygen from the lungs. The food products are in the form of solutions and emulsions, and are absorbed by the veins and lymphatics. Their evolution into blood and tissue pabulum is carried on while circulating in the vessels and passing through the various organs, as the spleen, liver, red marrow of bones,

etc. The capillaries serve as the ultimate distributers of the renovated blood to the tissues, which assimilate the new and give up the old. From the intercellular and lymph spaces, this blood fluid, charged with waste products, is then taken up by the veins and lymphatics and passed to and through various excretory organs, as the lungs, skin, kidneys, liver, etc., which separate the effete materials to be cast off.

The blood makes a complete circuit of the body, on an average, in thirty-two or thirty-three seconds, or during twenty-seven heart-beats.

In the adult, the blood constitutes one-thirteenth part of the weight of the body; in the newborn infant, one-nineteenth.

Life is endangered by hemorrhage, in proportion to the amount and rapidity of the bleeding. In adults, when one-half the total blood is lost suddenly, death is liable to take place, and in newly born children, when a few ounces are lost. The old, the young and the adipose bear the loss of blood badly.

NERVOUS SYSTEM.

SPINAL NERVES.

(A)—*Cervical Plexus*, consisting of first four cervical nerves, (1), (2), (3), (4).

(B)—*Brachial Plexus*, consisting of (5) fifth cervical, (6) sixth cervical, (7) seventh cervical, (8) eighth cervical and (9) first dorsal nerves.

(10)—Second dorsal. (11)—Third dorsal.

(C)—*Lumbar Plexus*, consisting of (12) the first lumbar, (13) second lumbar, (14) third lumbar, (15) fourth lumbar, and the dorsi-lumbar cord.

(D)—*Sacral Plexus*, consisting of (16) the fifth lumbar, (17) first sacral, (18) second sacral, (19) third sacral, and (20) part of fourth sacral.

(21)—Fifth sacral. (22)—Coccygeal.

(a)—Phrenic—internal respiratory.

(b)—Long thoracic—external respiratory.

(c)—Spinal Cord.

(d)—Brain.

(E)—Method of communication of Spinal Nerves with Sympathetic, by a twig which is composed of white matter from the cord to the ganglion and gray matter from the ganglion to the cord.

CRANIAL NERVES.

(F)—Olfactory.
(G)—Optic.
(H)—Motor Oculi.
(I)—Patheticus.
(J)—Tri-facial. (a)—Ophthalmic division. (b)—Superior maxillary division. (c)—Inferior maxillary division. (e,h)—Dental branches. (f)—Branch to palate. (g)—Lingual—special nerve of taste to tongue. (j)—Supra-orbital branch of ophthalmic division.
(K)—Abducens.
(L)—Portio dura—facial nerve—nerve of expression. (The Portio-mollis not shown.)
(M)—Eighth nerve. (m)—Glosso-Pharyngeal branch. (n)—Pneumogastric branch. (p)—Spinal Accessory branch.
(N)—Hypoglossal nerve.

SYMPATHETIC SYSTEM.

(I)—Cervical portion: (1)—Superior, (2)—Middle, (3)—Inferior Cervical Ganglia.
(II)—Thoracic portion.
(III)—Lumbar portion.
(IV)—Sacral portion.
(V)—Ganglion impar.

The Cephalic portion consists of four pairs of ganglia, namely, the ophthalmic, the spheno-palatine, the optic and the sub-maxillary—all in connection with the fifth cranial nerve, but communicating freely with the other cranial nerves.

The Sympathetic System has a double chain of ganglia, placed on each side of the bodies of the vertebrae. In the thorax they lie in front of the heads of the ribs. The ganglia correspond mostly with the vertebrae, and the divisions of the latter into regions. Each has a branch of communication with the spinal nerves—and all with each other—composed of white and gray matter.

These ganglia are the *lateral* or vertebral. They give off branches which go, chiefly, to the thoracic, abdominal, and pelvic cavities, forming the *collateral* or pre-vertebral ganglia, or centers, named the cardiac, the solar, and the hypogastric plexuses. From these gangliated plexuses, branches are again given off to form the *terminal* ganglia, or plexuses, which surround and accompany all the arteries of the viscera.

The sympathetic has independent functions, due to its own gray matter, such as are found in the automatic ganglia of the heart, the mesenteric plexus of the intestines, and those for the uterus, ureters, and walls of blood-vessels.

The dependent functions of the sympathetic are those which inhibit, augment, or modify impulses from the cerebro-spinal centers.

THE SPINAL CORD.

The *spinal cord* is that part of the central nervous system contained in the spinal canal, extending from the foramen magnum to the junction of the first and second lumbar vertebrae. It is fifteen

to eighteen inches in length, and has a cervical and a lumbar enlargement. A median fissure, before and behind, divides it into symmetrical halves connected by a commissure. The gray matter is in the center, in the form of two crescents, placed with their convexities together, giving an anterior and a posterior horn for each lateral half. Around the gray matter, the white conducting matter is disposed as tracts or columns, between or through which, the anterior and posterior roots of the spinal nerves pass to or from the horns of the gray matter.

The spinal cord is, first, a conducting medium; second, a center, or centers, for reflex action; third, for automatic impulses. It conducts out-going impulses as motor to muscles, vaso-motor, to blood-vessels, secretory, to glands, trophic, to the tissues. The paths for the out-going impulses are, chiefly, the motor tracts from the brain—the direct pyramidal in the anterior median part, and the crossed pyramidal in the posterior part of the lateral columns. Fibers from these tracts pass to and through the cells of the anterior horn of each segment to the anterior roots of the spinal nerve. Hence, the motor tracts diminish in size from above downwards. It also conducts in-going impulses causing *general* sensations—cutaneous, articular, muscular, visual; *special* sensations—tactile, pain, heat, exciting reflex and automatic centers. These in-going impulses come from the periphery—through the posterior roots of the spinal nerves, to and through the cells in the posterior horns of the

gray matter and thence upward through the *sensory tracts*—the posterior median and the posterior lateral columns. The sensory tracts increase in size from below upwards. Impulses are also conducted, from one segment to another, through the "association tracts"—the anterio-lateral column—which are of uniform size throughout the cord.

A center for a spinal reflex is that part of the gray matter which transfers a stimulus from the in-going fibre of the posterior root to the out-going fibres of the anterior root, constituting the middle part of the reflex arc.

The spinal reflexes are the superficial or *cutaneous*, the deep or *tendon reflexes* and the *organic*. The cutaneous reflexes are the *plantar*, the *cremasteric*, the *gluteal*, the *abdominal*, the *epigastric* and the *inter-scapular*. The deep reflexes are the *knee-jerk*, the *jaw-jerk*, the *ankle clonus*, and the *abdominal reflex*. The organic reflexes are concerned in the acts of respiration, circulation, secretion, micturition, defecation, etc.

The automatic centers of the cord are those which retain their activity after being separated from the medulla, but, normally, are subject to the control of the higher centers of the medulla and cerebrum and are subordinates to these. Examples are the celio-spinal center for dilating the pupil (opposite the lower cervical and the upper two dorsal vertebrae); the ano-spinal center in the lower lumbar segments; the vesico-spinal about the fourth or fifth lumbar; the vaso motor centers; the sweat centers.

A segment of the spinal cord is that portion of its entire thickness which corresponds to the origin of a pair of spinal nerves. There are, hence, thirty-one segments, each of which has its own special functions as a nerve center, and also functions for transmitting and modifying impulses from other segments and distant centers.

Each of the thirty-one pairs of spinal nerves has two roots of origin from the cord—a posterior, afferent or sensory root, with a ganglion of gray matter, and an anterior, efferent or motor root. The two roots join at the intervertebral foramen, forming a compound nerve, which then separates into an anterior and a posterior division, or ventral and dorsal, each of which has special relations—the dorsal supplying the structures about the spinal column. They are smaller than the ventral, except those of the first and second—the sub-occipital and the great occipital—which supply the back part of the scalp.

The ventral divisions supply all the anterior parts of the body. Those for the limbs join and intermingle so as to form plexuses. The ventral plexus for the upper limb is derived from five spinal nerves, while the lumbo-sacral plexus for the lower limb is derived from nine.

As a general rule, a particular nerve trunk supplies those parts which are associated in function —as the muscles which move a joint, (muscular branch), the joint itself, (articular branch), the skin about the joint and insertion of the muscles (cutaneous branch).

The roots of the first cervical nerve pass slightly upward in the canal to reach the foramen of exit. Those of the second pass horizontally, while all others pass downward in the canal to reach the foramen of exit, the spinal canal being much larger than the cord.

The origins of the nerves in the spinal cord have the following relations to the spinous processes of the vertebrae:

First cervical—level of foramen magnum.

Second cervical—a little below occipital bone.

Third cervical—middle of space between occipital bone and spinous process of axis.

Fourth cervical—spine of axis.

Fifth cervical—spine of third vertebra.

Sixth cervical—between third and fourth spines.

Seventh cervical—from spine of fourth to spine of fifth.

Eighth cervical—below spine of fifth vertebra.

First dorsal—spine of seventh cervical vertebra.

Second dorsal—seventh cervical to first dorsal vertebra.

Third dorsal—first dorsal vertebra and below.

Fourth dorsal nerve—second dorsal vertebra.

Fifth dorsal—third dorsal vertebra.

Sixth dorsal—fourth dorsal vertebra.

Seventh dorsal—fifth dorsal vertebra and above.

Eighth dorsal—from fifth to sixth dorsal vertebra.

Ninth dorsal—from sixth to seventh dorsal vertebra

Tenth dorsal—from seventh to eighth dorsal vertebra.

Eleventh dorsal—from eighth to ninth dorsal vertebra.

Twelfth dorsal—from ninth to eleventh dorsal vertebra.

The *five lumbar* nerves arise from between spines of eleventh and twelfth dorsal vertebrae. The *five sacral* and the *coccygeal* arise from level of spine of twelfth dorsal to first lumbar. The cord terminates at lower border of first lumbar vertebra.

Hence, any lesion which paralyzes the neck and upper limbs must be above the fifth cervical vertebra. The phrenic nerve—a part of the third and fourth—is affected only when the lesion is at or above the axis. A lesion at the sixth or seventh cervical paralyses all the intercostal muscles; at the third dorsal, all spaces below the third are affected; at the fifth dorsal the abdominal walls; at the eleventh dorsal the lumbar and sacral plexuses become involved; at the twelfth dorsal the sacral plexus is paralyzed.

[*For the Brain see description of the Head.*]

THE BODY AND EXTREMITIES.

INDEXES TO SECTIONS.

MUSCLES OF THE ANTERIOR PART OF THE BODY.

(d) Isthmus of the Thyroid gland, covering the upper part of the Trachea.
(f) Clavicle.
(g) Manubrium of Sternum.
(h) Central part of Sternum (Gladiolus).
(i) Coracoid process of Scapula.
(k) Acromion process.
(l) First rib. (m) Second rib. (n) Third rib.
(o) Fourth rib. (p) Fifth rib.
(r) Head of Humerus (greater tuberosity).
(s) Interclavicular ligament.
(t) Rhomboid ligament.
(u) Aponeurosis of External Intercostals.
(v) Acromio-clavicular ligament.
(w) Coraco-acromial ligament.
(17) Platysma-Myoides—a cutaneous muscle, the upper end of which is one of the muscles of expression.
(18) Sterno-mastoid (sternal portion).
(19) Sterno-hyoid.
(20) Scalenus Anticus.
(21) Pectoralis Major.
(22) Pectoralis Minor.

(23) Subclavius.

(24) Serratus Magnus—interdigitating with (25) External Oblique of the abdomen.

(26) Linea Alba.

(27) Rectus. (28) Its transverse aponeuroses (Linea Transversae).

(29) Pyramidalis.

(30) Internal Oblique.

(31) Poupart's Ligament, or Crural Arch, composed of the thickened lower border of the aponeurosis of external oblique. Below it, is the Saphenous opening—the outer end of the Femoral canal, through which comes Femoral Hernia.

(32) External boundary (Pillar) and (33) internal boundary (Pillar) of (34) external abdominal ring, which is an opening in the aponeurosis of external oblique, caused by divergence of its fibers. The lower boundary of the ring is the crest of the Pubes.

(35) Internal abdominal ring, the opening in transversalis fascia, situated a half inch above Poupart's ligament, and midway between spines of the Pubes and Ilium.

(36) Inguinal canal for the spermatic cord, and through which oblique inguinal hernia makes its way. Its roof is the conjoined lower border of internal oblique and transversalis muscles; its floor, Poupart's ligament; its outer wall, the aponeurosis of external oblique; its inner wall, the transversalis fascia, upon which the number 36 is placed.

(37) Border of Deltoid muscle.
(38) Coraco-Brachialis.
(39) Short head, and (40), long head, of biceps.

THE THORAX.

(5) Clavicle.
(6) Sternum. (6) Manubrium. (6′) Gladiolus. (6″) Ensiform Cartilage.
(7) Ribs.
(8) Costal Cartilages—those of the false ribs—eighth, ninth and tenth—join that of the seventh.
(9) Sterno-Clavicular joint with ligaments, and (9′) without.
(10) Costo-Sternal joint with ligament.
(11) Interclavicular notch.
(12) Internal and (12′) External Intercostal muscles—the analogues of the oblique muscles of the abdomen. The external are aponeurotic from the sternum to the ends of the costal cartilages, and both are aponeurotic from the angles of ribs to spine. Between these two muscular planes, in an osteo-fibrous canal on the under border of each rib, are the intercostal muscles and nerves.
(13 (13′) Costal (Parietal) Pleurae.

MEDIASTINUM AND LUNGS.

(14) Mediastinum—the space from before backwards, from sternum to spine, bounded laterally by the Pleurae. Nothing but the cellulo adipose tissue is shown. The space is divided into the *anterior* (from the ster-

num to pericardium), which contains the remains of the Thymus gland, Triangularis Sterni muscle, left Brachio-Cephalic vein (crossing behind first part of sternum), Lymphatic glands and left internal Manunary artery and vein; the *middle*, which contains the heart with its large vessels and Phrenic nerves; and the *posterior*, containing the Oesophagus, Pneumogastric nerves, Aorta, Thoracic Duct, Azygos vein, Trachea and Lymphatic glands.

(15) (15) Upper and lower lobes of left lung.

(16) (16) (16) Upper, middle and lower lobes of right lung.

INTERIOR OF LUNGS.

(17) Trachea.

(A) Arch of Aorta.

(B) Pulmonary artery, which begins in front of root of aorta and bi-furcates under its arch, giving a branch to each lung. It conveys venous blood from the right ventricle to the lungs.

(C) Superior Vena Cava, emptying into right auricle.

(D) One of Left Pulmonary veins, there being two on each side which convey the purified blood from the lungs to the left auricle, by four openings.

THE HEART.

(a) Right Auricle.

(b) Right Auricular appendage.

(c) Left Auricle.
(d) Left Auricular appendage.
(e) Mitral (Left Auriculo-Ventricular) valve.
(f) Tricuspid (Right Auriculo-Ventricular) valve.
(g) Musculi Papillares, with the free ends of which the flaps of the valves are connected by (h) the Chordae Tendinae.
(i) Ventricular Septum.

ABDOMEN AND ABDOMINAL VISCERA.

(14) Loop of large intestine (Sigmoid Flexure of Colon).
(15) Bladder.
(16, to the left). Great Omentum with Omental vessels, branches of the Gastric.
(16, to the right). Transversalis fascia and subperitoneal fat, in which are imbedded (C′) the deep epigastric vessels—the artery, a branch of the external iliac, passing upward and inward to reach the sheath of the rectus muscle, in which it passes upward to anastomose with the superior epigastric, the terminal branch of the internal mammary. In obstruction of the abdominal or thoracic aorta, collateral circulation is carried on largely by this circuit. The veins (the inner one the larger) passing down, join the external iliac.
(17) Fold of Peritoneum — Median Vesical ligament. (a2) Parietal Peritoneum.
(X) Spermatic artery and vein.

(1) Right lobe—lower surface.
(2) Left lobe.
(3) Gall bladder distended, which normally projects from under the ninth costal cartilage. When distended, and the liver is enlarged, it approaches the umbilicus.
(4) Portal vein subdividing.
(5) Hepatic veins uniting to join the vena cava as it lies in its groove on posterior border of liver.
(6) Common bile duct, between which and the Portal vein, is the Hepatic artery—a branch of the Coeliac axis.
(7) Hepatic duct joining (8) the Cystic duct, to make the common duct.
(9) Neck of gall bladder.
(10) Cystic artery.
(11) The Round ligament—the remains of the umbilical artery, lying in the longitudinal fissure between the double fold of peritoneum (12), called the Falciform or Suspensory ligament.

STOMACH AND INTESTINES.

(1′) Oesophageal opening of stomach.
(3) Cardiac end of stomach and anterior wall.
(3′) Rugae of mucous membrane.
(4) Pylorus.
(5) Beginning of Duodenum.
(7) Jejunum and Ilium.
(8) Vermiform Appendix.

(9) Coecum (Caput Coli).
(10) Ascending Colon.
(11) Hepatic Flexure.
(12) Transverse Colon.
(13) Splenic Flexure.
(14) Descending Colon, terminating in the Sigmoid Flexure.
(15) Bladder, distended.

SECTION OF BODY, AND SHOULDER AND HIP JOINTS

(1) Superior Constrictor muscle of Pharynx.
(2) Middle.
(3) Inferior.
(4) Mucous membrane of Pharynx.
(5) Clavicle.
(6) Acromio-Clavicular ligament.
(7) Ribs.
(8) Acromion process of Scapula.
(9) Coraco-acromial ligament.
(10) Tendon of long head of Biceps.
(11) Capsular ligament.
(12) Anterior or inner surface of external Intercostal muscles.
(12′) Internal surface of internal Intercostals.
(13) Scapula.
(14) Head of Humerus, the lesser tuberosity of which, looks directly forward.
(15′) Surgical neck of Humerus which extends from tuberosities to lower border of axilla.
(16) Coracoid process of Scapula.
(17) Articular Cartilages of head of Humerus and Glenoid Fossa.

(18) Spleen.
(19) Pancreas.
(20) Right kidney.
(20′) Pyramidal substance of kidney.
(21) Supra-renal Capsule.
(22) Pelvis.
(22′) Calyces.
(23) Cortical substance.
(24) Ureter.
(25) Transversalis muscle.
(26) Psoas.
(27) Iliacus Internus.
(28) Pyriformis, the anterior border being continuous with the Coceygeus, forming the floor of the Pelvis.
(29) Sacrum.
(30) Sacro-Iliac ligament.
(31) Capsular ligament of hip joint. It is reinforced, on the anterior surface, by (32) the inverted "Y" or Ilio-Femoral ligament, which arises from the anterior-inferior spine of Ilium and is inserted into (33) the intertrochanteric line of Femur.
(34) Outer surface Great Trochanter.
(35) Tuberosity of Ischium.
(36) Anterior pubic ligament.
(37) Obturator membrane.
(38) Pectineal eminence.
(39) Crest of Ilium, ending below in the anterior superior spine.
(40) Section of rim of Acetabulum, and articular cartilage.

(41) Synovial sac of hip joint.
(42) Lesser Trochanter.
(A) Aorta.
(E) Inferior Vena Cava.
(F) Right and left common Iliac arteries.
(F′) Internal Iliac.
(F″) External Iliac.
(G) Left common Iliac vein.
(G′) Left external Iliac vein.
(H) Common Femoral artery.
(H′) Superficial Femoral.
(H″) Deep Femoral.
(I) Right Azygos vein, which takes the place of the vena cava within the chest, receiving all the right intercostal veins and after arching over the right bronchus, empties into the superior vena cava. It communicates with the inferior cava at its beginning, either directly or indirectly. It is joined by the left azygos about the middle of the chest.
(k) Subclavian artery, terminating at the lower border of the first rib, in the axillary, which terminates in (1), the brachial, at the lower border of the teres major muscle.
(m) Acrominal Thoracic.
(n, n′) Short and Long Thoracic.
(o) Subscapular—giving off dorsalis scapulae.
(p) Anterior and (q) Posterior Circumflex.
(r) Superior Profunda.
(s) Branches of Transversalis Colli.
(t) Intercostal arteries and veins.
(u) Splenic artery.

(v) Renal artery.
(v′) Lumbar artery.
(w) Renal vein.
(x) Spermatic artery and vein.
(y) Inferior Mesenteric.
(a′) Lumbar artery and vein.
(b′) Superior Gluteal.
(b2) Ilio-lumbar.
(c′) Deep Epigastric.
(d′) Circumflex Iliac.
(e′) Sciatic and Internal Pudic.
(f′) External Circumflex.
(g′) Obturator.

UPPER EXTREMITY.

PLATE I.

Arm—(1) Acromion process. (12) Fascia of pectoralis muscle. (13) Deep fascia of arm. (18) Deltoid muscle covered with fascia. (19) Pectoralis major muscle. No arteries except small muscular (B) or cutaneous branches are shown. (I) Subcutaneous veins. (II) Basilic vein. (III) Cephalic vein. (IV) Median and median cephalic veins. (a) Supraclavicular nerve. (b) Posterior cutaneous, from the circumflex. (c) Branches from the anterior thoracic. (d) Internal cutaneous. (e) Lesser internal cutaneous. (h) Musculo-cutaneous.

Fore-arm and Hand—(9) Deep fascia. (10) Bicipital fascia. (11) Palmar fascia. (11′) Transverse palmar ligament. (12) Anterior annular ligament. (14) Paniculus adiposus of the fingers. (29)

Palmaris Brevis muscle. (III) Cephalic or radial vein. (IV) Median vein. (V) Median Basilic vein. (a) Branches of internal cutaneous nerve. (b) Same. (c) Branches of musculo-cutaneous nerve. (i) Palmar branch of ulnar nerve. (m) External cutaneous branch from musculo-spinal nerve.

PLATE 2.

Arm—(1) Acromial end of clavicle. (2) Coracoid process of scapula. (3) Greater tuberosity of head of humerus. (4) Lesser. (5) Bicipital groove. (8) Coraco-clavicular ligament. (9) Coraco-acromial ligament. (10) Capsular ligament. (15) Bicipital fascia. (16) Pectoralis major tendon. (17) Triceps muscle. (19) Pectoralis major. (20) Biceps. (20′) Short head of biceps. (20″) Long head of biceps. (21) Coraco-brachialis muscle. (22) Brachialis anticus muscle. (23) Triceps muscle. (A) Brachial artery. (D) Inferior profunda. (III) Cephalic vein. (IV) Median Cephalic. (V) Venae comites—brachial. (VI) Beginning of Cephalic.

Fore-arm and Hand—(1) Internal condyle of humerus. (9) Deep fascia. (10) Aponeurosis of biceps muscle. (11) Palmar fascia. (12) Anterior annular ligament. (13) Sheaths of flexor tendons —circular and oblique fibers. (15) Biceps muscle. (15) Inferior bicipital tendon. (16) Brachialis anticus muscle. (17) Triceps. (18) Supinator longus. (22) Flexor carpi radialis. (23) Palmaris longus. (24) Flexor sublimis digitorum. (27) Flexor carpi ulnaris. (28) Pronator quadratus. (29) Palm-

aris brevis. (30) Abductor pollicis. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (36) Lumbricales. (B) Radial artery. (G) Ulnar artery, forming the superficial palmar arch. (K) Digital branches. (N) Superficial radial nerve. (N″) Dorsal branch.

PLATE 3.

Arm—(1) Acromio-clavicular joint. (2) Coracoid process. (3) Greater tuberosity of head of humerus. (4) Lesser. (11) Sheath of biceps tendon. (16) Insertion of pectoralis major muscle. (17) Insertion of deltoid. (18) Deltoid. (20′) Long head of biceps. (20″) Short head. (21) Coraco-brachialis. (22) Brachialis anticus. (23) Triceps. (A) Brachial artery. (B) Muscular branches. (C) Superior profunda. (D) Inferior profunda. (d) Internal cutaneous nerve. (f) Median nerve. (g) Ulnar. (h) Musculo-cutaneous.

Fore-arm and Hand—(1) Internal condyle. (2) Radius. (3) Ulna. (4) Pisiform bone. (5) Unciform bone. (6) First phalanges. (7) Second. (8) Third phalanges. (15) Biceps tendon. (16) Brachialis anticus. (19) Extensor carpi radialis brevior. (20) Supinator brevis. (24) Flexor sublimis digitorum. (26) Flexor longus pollicis. (28) Pronator quadratus. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (37) Interossei. (A) Brachial artery. (B) Radial. (C) Superficial volar branch. (D) Dorsal

branch. (E) Ulnar artery. (F) Interosseous. (G) Superficial branch for superficial palmar arch. (K) Digital branches. (V) Venae comites. (d) Median nerve. (d′) Muscular branch. (e) Internal interosseous. (g) Digital branches. (k) Ulnar nerve. (k, k′) Digital and muscular branches. (l) Radial nerve. (n) Superficial radial. (n′) Anterior. (n″) Posterior branches.

PLATE 4.

Arm—(2) Acromion process. (2′) Coracoid process. (3) Clavicle. (4) Greater tuberosity. (11) Capsular ligament. (12) Sheath of biceps tendon. (20) Long head of biceps. (24) Internal head of triceps muscle. (24″) External head of triceps. (24‴) Middle or scapular head of triceps. (A) Axillary artery. (B) Brachial artery. (C′) Acromial branch of transverse capular artery. (D) Thoracic branch of brachial artery. (E) Acromial thoracic. (F) Long thoracic branch. (G, G′) Subscapular artery and branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda.

Fore-arm and Hand—(16) Anterior ligament, elbow joint. (18) External lateral ligament. (18′) Part of orbicular ligament. (20) Interosseous ligament. (5) Styloid process of ulna. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Trapezium. (11) Carpo-metacarpal joint of thumb. (12) Metacarpal. (13) First phalanges. (14) Second phalanges. (15)

Third phalanges. (16, 18, 18′) Ligaments of elbow joint. (31) Pronator radii teres. (32) Supinator brevis muscle. (33) Flexor carpi radialis. (34) Pulmonis longus. (35) Flexor sublimis digitorum. (36) Flexor profundis digitorum. (37) Flexor longus pollicis. (38) Pronator quadratus. (39) Adductor pollicis. (40) Abductor minimi digiti. (41) Palmar interosseous. (B) Radial artery. (D) Dorsalis pollicis. (G) Ulnar. (G′) Ulnar recurrent. (H) Interosseous. (I) Metacarpal branch. (K) Termination of ulnar which is continued as the superficial palmar arch.

PLATE 5.

Arm—(2) Acromion. (3) Clavicle. (22) Coracoid process. (4) Greater tuberosity of head of humerus. (12) Sheath of biceps tendon. (19) Insertion of pectoralis major. (20) Biceps tendon, long head. (21) Short head. (22) Coraco-brachialis. (23) Brachialis anticus. (24) Triceps muscle. (A) Axillary artery. (B) Brachial. (F) Long thoracic. (G,G) Subscapular and its branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda. (N) Anastomotica magna.

Fore-arm and Hand—(2) External condyle of humerus. (4) Ulna. (6) Radius. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform. (10) Trapezium. (11) Trapezoid. (12) Metacarpal. (13, 14) Phalanges of thumb. (16) Anterior ligaments. (20) Interosseous ligaments

of elbow joint. (22, 23, 24) Ligaments of wrist joint. (30) Tendon of biceps—insertion. (31) Pronator radii teres. (32) Supinator brevis. (36′) Tendons of flexor sublimis digitorum. (38) Pronator quadratus. (41) Interosseous. (A) Brachial artery, lower end. (B) Radial artery. (C) Superficialis volæ. (D) Dorsal branch of radial. (D′, D″) Dorsal branches to thumb. (E) First digital branch. (E′, E″) Branches to ulnar and radial sides of thumb (princeps pollicis). (F) Deep palmar branch. (G) Ulnar artery. (G′) Ulnar recurrent interosseous. (H′) Anterior interosseous. (I) Dorsal branch. (K) Ulna dividing into deep and superficial branches; the superficial joining (C) to form (K), the superficial palmar arch—the deep branch joining from the radial to form (L′), the deep palmar arch. (M) Digital branch to little finger. (N) Common digital branches. (O) Interosseous arteries. (P) Digital.

PLATE 6.

Arm.—(2) Coracoid process. (3) Clavicle. (4) Greater tuberosity of humerus. (9) Coraco-clavicular ligament. (10) Coraco acromial. (11) Capsular ligament. (12) Sheath of biceps tendon. (16) Anterior ligament of elbow joint. (17, 18) Lateral ligaments. (20) Long tendon of biceps. (18′) Orbicular ligament. (A) Position of axillary artery. (D′) Long thoracic. (E) Anterior thoracic. (F) Subscapular. (G) Internal cutaneous of arm. (G′) Posterior branch. (H) Middle cutaneous. (H′) Ulnar cutaneous branch. (I)

Musculo cutaneous nerve. (K) Circumflex. (L) Posterior cutaneous of arm. (M) Median nerve. (N) Ulnar nerve. (O) Muscular spiral. (O′) External cutaneous branch.

Fore-arm and Hand—(1) Internal condyle of humerus. (2) External. (3) Internal part of trochlear surface of humerus. (4) Ulna. (5) Styloid process. (6) Radius. (6′) Neck of radius. (6″) Bicipital tuberosity. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Scaphoid. (11) Trapezium. (12) Metacarpus. (13, 14, 15) Phalanges. (19) Oblique ligament. (20) Interosseous membrane. (21, 24) Straight and oblique volar ligaments. (22, 23) Lateral ligaments. (25, 26) Anterior carpal ligaments. (27, 28, 29, 30) Carpal, metacarpal and transverse ligaments. (a) Lesser internal cutaneous nerve. (b′) Palmar branch. (b″) Ulna cutaneous branches. (c) Musculo cutaneous. (d) Median nerve. (d′) Muscular branches. (e) Interosseous branch. (f) Long palmar. (g) Digital branches. (h) Ulnar nerve. (i) Dorsal branch. (k) Palmar branch. (k′) Superficial palmar branch. (k″) Digital branches. (k‴) Deep ulnar branch. (l) Radial. (l′) External cutaneous branch. (m) Posterior branch. (n) Anterior. (n′) Dorsal branch of thumb.

LOWER EXTREMITY.

PLATE I.

Thigh—(1) Patella. (5) Fascia lata. (6) Crural fascia. (8) Bursa patellae. (I) Internal saphenous vein. (II) Subcutaneous veins. (a) External

cutaneous nerve. (b) Branch of genito-crural nerve. (c). Branch of inguinal. (e) Internal cutaneous nerve. (f) Middle cutaneous.

Leg—(2) Internal malleolus. (4) External malleolus. (6) Deep fascia of the leg. (7) Anterior annular ligament. (8) Dorsal fascia of the foot. (I) Subcutaneous veins. (II) Long saphenous vein. (a) Long saphenous nerve. (b) Musculo-cutaneous. (c) Cutaneous branches of external popliteal. (d) Internal cutaneous of the dorsum of foot. (e) Middle cutaneous of dorsum. (g) Digital nerves.

PLATE 2.

Thigh—(1) Patella. (2) Internal condyle of femur, (3) of tibia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus exterus. (14) Pectineus muscle. (15) Adductor longus. (17) Gracilis. (I) Long saphenous vein. (II) Subcutaneous veins. (e) Branches of internal cutaneous nerve.

Leg—(1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Metatarsal. (7) Anterior annular ligament. (9) Tibialis anticus. (10) Extensor digitorum longus. (10′) Peroneus tertius. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (A) Anterior tibial artery. (A′) Dorsalis pedis artery. (III) Deep veins of leg.

PLATE 3.

Thigh—(1) Patella. (2) Internal condyle of femur. (3) Of tibia. (5) Deep fascia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (13) Psoas and internal iliac muscles. (14) Pectineus. (15) Adductor longus. (16) Adductor magnus. (17) Gracilis. (A) Femoral artery. (B) Deep femoral. (C) Muscular branches. (I) Internal saphenous vein. (c) Branch of ilio-inguinal nerve. (e) Branches of internal cutaneous. (f) Middle cutaneous. (g) Saphenous branches. (h) Muscular branches of crural nerve. (i) Musculo-cutaneous branches of crural nerve.

Leg—(1) Tibia. (2) Internal malleolus. (4) External malleolus. (5) Metatarsal bones. (6) Fascia. (7) Anterior annular ligament. (9) Tibialus anticus tendon. (10) Extensor longus digitorum. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (b) Musculo-cutaneous nerves. (d) Dorsal cutaneous of foot. (e) Middle dorsal cutaneous. (f) Terminal branch of external saphenous. (g) Digital branches. (h) Anterior tibial. (h′) Internal. (h″) Internal branches of same.

PLATE 4.

Thigh—(1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (13) Gracilis muscle. (14) Adductor longus muscle. (15) Ad-

ductor brevis. (16) Adductor magnus. (17) Insertion of pectineus muscle. (A) Femoral artery. (B) Deep femoral. (D') First perforating artery. (F) Muscular branches. (5) Tuberosity of tibia. (7) Ligamentum patellæ (middle part). (8) Internal lateral part. (9) Internal lateral ligament. (10) External lateral ligament (anterior part). (10') Posterior part. (11) Synovial capsule.

Leg and Foot.—(1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (9) Anterior annular ligament. (10) Interosseous membrane. (10') Tibiofibular ligament. (10") Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (13) External lateral ligament (anterior part). (14) Transverse metatarsal ligaments. (15) Capsular and lateral ligaments. (16) Peroneus longus and brevis muscles. (17) Tendons of extensor longus digitorum muscle, (18) of extensor longis pollicis, (19) of tibialis anticus. (20) Dorsal interosseous muscles. (A) Anterior tibial. (A') Dorsalis pedis.

PLATE 5.

Thigh.—(1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (7) Ligamentum patellæ. (8) Lateral ligament of patella. (9) Internal lateral ligament of knee joint. (10) External lateral ligament (anterior part.) (10') Posterior part. (11) Synovial capsule. (16) Adductor magnus. (17) Insertion of pectineus mus-

cle. (A) Femoral artery. (B) Profunda femoris. (C) Descending branch of external circumflex artery. (D') First perforating. (D'') Second perforating. (D''') Third perforating. (E) Nutrient artery of femur. (F) Muscular branches. (G) Anastomotica magna. (H) Popliteal. (I) Muscular branches. (K) Superior external auricular. (L) Superior internal auricular. (M) Middle articular. (N) Sural branches. (O) Inferior external articular. (P) Inferior internal articular branches. (Q) Anterior tibial.

Leg and Foot.—(1) Tibia. (2) Internal. (3) External malleolus. (4) Fibula. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (10) Interosseous membrane. (10') Tibio fibular ligament. (10'') Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (12) Astragalo-scaphoid. (13) Anterior external lateral. (13') Middle external lateral. (14) Transverse metatarsal. (15) Capsular ligaments. (A) Anterior tibial artery. (A') Dorsalis pedis. (B) Recurrent tibial. (C) External malleolar. (C') Internal. (D) External tarsal. (D') Internal tarsal. (D'') Anterior tarsal. (E) Metatarsal. (F) Dorsal interosseous. (F') Dorsalis hallucis. (F'') Deep plantar branch of same. (G) Posterior tibial. (H) Peroneal. (H') Anterior peroneal. (K) Posterior internal malleolar. (K') Posterior external. (L) Internal plantar. (L') Internal superficial branch. (M) External plantar. (N) Superior plantar arch. (O) Sural branch.

PLATE 6.

Thigh.—(1) Femur. (2, 3) Internal and external condyles. (4) Patella. (5′) Tuberosity of tibia. (6) Head of fibula. (7) Ligamentum patellæ. (8) Internal lateral part. (9) Internal lateral ligament of knee. (10, 10′) External lateral ligament. (11) Synovial capsule. (a) Anterior obturator nerve. (b) Internal cutaneous. (c) Anterior internal cutaneous. (d) Long saphenous. (e) Great sciatic. (f) External popliteal or peroneal. (f′) Posterior cutaneous branches of leg. (i) Internal popliteal nerve. (k) Sural or long cutaneous nerve. (l) Anterior external cutaneous.

Leg and Foot.—(Figures refer to same as in preceding plate).—(a) Long saphenous nerve. (b) Musculo cutaneous or superficial peroneal. (c) Anterior cutaneous branches. (d) Internal cutaneous branch of foot. (e) Middle cutaneous branch. (f) Posterior external cutaneous of leg. (g) Digital branches. (h) Anterior tibial. (h′) Internal branch. (h″) External branch. (i) Posterior tibial. (k) External saphenous branch. (k′) External cutaneous branch. (l) Internal plantar. (m) External plantar. (n) Digital plantar.

THE HEAD.

THE SKULL, SCALP, ETC.

The skull, the bony part of the head, consists of the cranium and the face. Eight bones compose the former and fourteen the latter. The immovable joints of the skull are called sutures (5) of which those of the vertex are the most important. These sutures are best named anatomically, as the fronto-parietal (*coronal*), the inter-parietal (*sagittal*), occipito-parietal (*lambdoid*). The average thickness of the flat bones of the cranium is one-fifth of an inch. The thickest parts are the occipital protuberance and at the parietal and frontal eminences. The temporal region is the thinnest. These flat bones have some peculiarities. The outer layer of "compact tissue" (external table) is thick and tough; the inner (internal table), thin and brittle. The cancellous tissue (*diploe*), most marked in middle life, is "intermediate like a soft leather cushion," and is channeled for numerous large veins with thin walls. The frontal, and part of the temporal groups of the diploic veins, discharge into the external veins of the head, while the occipital, and part of the temporal, discharge into the sinuses of the *dura-mater;* thus affording collateral relief for obstructed circu-

lation of the brain by the intercommunication of the internal and external venous systems. This relation explains the serious brain symptoms which are liable to follow even a slight septic inflammation of the scalp and lesions of the cranial bones. Great vascularity characterizes the bones of the cranium and face, as well as all the soft parts connected with them; hence, the relatively quicker and more certain repair of injuries, or wounds.

There are three kinds of sinuses: Those of the dura mater for the return of the venous blood from the brain; the cerebral sinuses, which are interspaces between its lateral halves or other parts; and those in the bone, as the frontal, sphenoidal, etc., which contain air and communicate with the air passages.

There are five distinct strata of tissues covering the cranium: 1. The skin. 2. Dense fibro-adipose tissue, in which are the hair bulbs and the cutaneous vessels and nerves. The arteries, adhering to and firmly embedded in this tissue, when cut, do not contract nor retract, and are with difficulty seized and drawn out with forceps; hence, the free hemorrhage in scalp wounds and the trouble in arresting it. 3. The occipito-frontalis muscle with its aponeurosis, which gives power to move the scalp, and which is, like the facial muscles, supplied by the facial nerve, and is classed as one of the muscles of expression. These three structures constitute the *scalp*, as the term is commonly used. 4. Loose areolar tissue, without fat, which allows the "scalp" to glide freely on 5. The

pericranium (external periosteum).

The remarkable vitality of the flaps in extensive wounds of the scalp is due not more to the free arterial supply and anastomosis than to the fact that the arteries are carried with the flap entering it from its base.

Cephalhaematoma is a blood tumor between the pericranium and the bone and is limited to one bone. The ordinary effusion of blood (haematoma), as from a bruise, is in the loose areolar tissue between the aponeurosis and the pericranium. It is liable to be diffuse, but is not often large, because the vessels in this tissue are small. Wounds of the scalp are not more prone to erysipelatous inflammation than other wounds. But phlegmonous inflammation (erroneously called erysipelas) does often occur if the wound is not properly treated. The loose areolar tissue is a favorable nidus for sepsis. The skin heals rapidly and confines septic secretions beneath, which diffuse rapidly. Drainage, keeping the angles of the wound open, and compression, are most important in scalp wounds.

(1) Frontal bone.
(2) Parietal.
(3) Occipital.
(4) Squamous portion of Temporal.
(5, 5) Fronto-parietal (Coronal) and Occipito-parietal (Lamboid) sutures.
(6) Malar.
(7) External Auditory Meatus.
(8) Orbicularis Palpebrarum muscle.

(9, 9) Zygomatici Major and Minor.
(10) Masseter muscle.
(11) Orbicularis Oris.
(12) Levator Menti.
(13) Sterno-mastoid.
(14) Levator Auguli Scapulae.
(15) Omo-hyoid—anterior part.
(16) Internal Jugular vein.
(17) Facial vein.
(18) Temporal vein.
(19) Common Corotid artery.
(20) Facial artery.
(21) Superficial Cervical nerves.
(22) Facial nerve.
(23) Supra-maxillary division.
(24) Trachea.
(25) Scalp.
(26) Skull.
(27) Cerebrum.
(28) Cerebellum.
(29) Spinal cord.
(30) Medulla Oblongata.
(31) Eyeball.
(32) Internal Rectus muscle
(33) Optic nerve.
(34) Internal surface of Malar bone.
(35) Inferior Maxillary.
(36) Anterior Naris.
(37) Inferior Dental artery and
(38) Nerve.
(39, 40) Cortex of Cerebrum, showing convolutions of gray matter.

(41) Corpus Callosum.
(42) Corpus Striatum.
(43) Optic Thalamus.
(44) Section of Cerebellum.
(45) Medulla Oblongata.
(46, 47) Outer wall of nasal cavity, showing the three turbinated bones and the meatuses —superior, middle and inferior—and the distribution of the olfactory nerve.
(48) The Hard palate—formed in front by the superior maxillary, and behind by the palato.
(49) Pharyngeal opening of Eustachian tube.
(50) Pharynx.
(51) Soft palate.
(52) Lateral portion of roof of mouth.
(53) Tongue.
(54) Sublingual gland.
(55) Epiglottis.
(56) Larynx.
(57) Junction of pharynx and oesophagus. This point is opposite the body of the fifth cervical vertebra (its lower border) and corresponds with junction of larnyx trachea.
(58) Body of fifth cervical vertebra.
(58') Spinal process of vertebra.

THE BRAIN.

The gray matter of the brain is disposed as a layer on the outer surface—the cortex with its con-

volutions; as circumscribed convolutions in the basal ganglia—corpus striatum, optic thalamus, corpora quadrigemina; or, as the central gray tube continued up from the spinal cord through the medulla and pons around the iter to the tuber cinereum. The white matter connects these parts in various ways—either longitudinally or transversely—the corona radiata (1), (2), (3), (4), connecting the cortex with the basal ganglia; the commissural fibers (c, c) connecting corresponding parts of the two hemispheres; the association fibers (a, a) connecting different areas of the same part; the longitudinal bundle of fibers, as pyramids, tracts, etc., connecting the gray matter of the spinal cord with all the brain centers.

The ventricles of the brain are the spaces between the different ganglia or parts.

DIAGRAM OF THE RELATIONS OF THE CENTRAL GANGLIA OF GRAY MATTER TO EACH OTHER AND TO THE SPINAL CORD.

(C, C).—Cortical gray matter of the cerebrum.

(C, S).—Corpus striatum.

(N, L).—Lenticular nucleus—the extra-ventricular part of former.

(T, o).—Optic thalamus.

(V).—Corpora quadrigemina.

(P).—Peduncle of cerebrum.

(H).—Tegmentum—the upper part of the peduncle.

(p).—Crusta—under part of peduncle.

(1, 1).—Corona radiata of corpus striatum.

(2, 2).—Corona radiata of lenticular nucleus.

(3, 3).—Corona radiata of the optic thalamus.

(4, 4).—Corona radiata of the corpora quadrigemina.

(5).—Direct fibers to cortex.

(6, 6).—Fibers from corpora quadrigemina to tegmentum.

(7).—Fibers of the optic thalamus.

(m).—Same fibers continued.

(8, 8).—Fibers from corpus striatum and nucleus to crusta.

(M).—Same continued in cord.

(S, S).—Course of sensory fibers.

(a, a)—Association system of fibers.

(c, c).—Commissural fibers.

(R).—Transverse section of spinal cord.

(v, W).—Anterior root.

(h, W).—Posterior root.

LEFT SIDE OF THE BRAIN SHOWING THE FISSURES, CONVOLUTIONS AND MOTOR AREAS, AND THEIR RELATION TO THE SKULL BONES AND THEIR SUTURES.

The outer surface of the cerebral hemispheres is divided into four lobes by the fissure of Sylvius, the fissure of Rolando, and the parieto-occipital fissure. These, from their depth, regularity, and early development, are called primary fissures. The frontal lobe is that part anterior to the fissure of Rolando. The parietal lobe is between the fis-

sure of Rolando and the parieto-occipital fissure. The occipital lobe consists of that part of the hemisphere below the parieto-occipital fissure. The temporo-sphenoidal lobe is that part which occupies the middle fosse of the skull, and is bounded before and above by the fissure of Sylvius and joins the occipital behind. The Island of Reil or central lobe—the fifth primary lobe—lies deep in the fissure of Sylvius, but does not show on the surface. Each of these primary lobes is sub-divided by secondary fissures, of more or less regularity, into secondary lobules called convolutions.

(K 1).—Bregma.

(K 2).—Parieto-frontal suture, crossing temporal ridge—the dotted semi-circular line.

(K 3).—Anterior inferior angle of parietal, joining the sphenoid and frontal bones, and where the suture begins.

(M).—Point on squamous suture crossed by a perpendicular line from depression in front of the meatus to the bregma.

(L 1, L 2).—Parieto-occipital fissure.

The numbers (1) to (14) and the letters (a), (b), (c), (d), refer to cortical centers and are the same as in description of following diagram.

(S).—Main part of fissure of Sylvius, separating the frontal from the tempero-sphenoidal lobes. It divides into an ascending, or perpendicular, and a horizontal ramus. The latter is bisected at the point (M).

(C).—Fissure of Rolando or central sulcus.

(A).—Ascending frontal convolution.

(B).—Ascending parietal convolution.

(f 1).—First or superior frontal fissure, corresponding to a curved line drawn parallel to the longitudinal fissure beginning at the supra-orbital notch.

(f 2).—Second or inferior frontal fissure, a little below, but nearly corresponding to the temporal ridge.

(f 3)—Pre-central fissure—sometimes called an extension of the ascending ramus of the fissure of Sylvius. It corresponds to the parieto-frontal suture and is frequently joined at right angles by (f 1) the first, (f 2) second, and (f 3) third frontal convolutions.

(i, p)—Inter-parietal suture separating (P 1) superior parietal lobule or convolution from (P 2) inferior parietal lobule or convolution. The upper part of (P 2) is the supra-marginal convolution or gyrus, and the lower and posterior part is the angular convolution or gyrus.

(c, m)—End of calloso-marginal fissure.

(P, o)—Parieto-occipital fissure—the division between the parietal and occipital lobes—and nearly corresponding to the beginning of the occipito-parietal suture.

(L 1, L 2)—Points on the parieto-occipital suture.

(o)—Transverse occipital fissure.

(o 2)—Inferior or longitudinal occipital fissure.

(O1, O2, O3)—First, second and third occipital convolutions.

(t 1)—First temporo-sphenoidal fissure—near-

ly parallel with horizontal branch of fissure of Sylvius, and nearly mid-way between it and

(t 2)—Second temporo-sphenoidal fissure.

(T1, T2, T3)—First, second and third temporo-sphenoidal convolutions.

DIAGRAM OF UPPER SURFACE OF THE BRAIN.

This plate shows three of the primary lobes: the *frontal*, with its four sub-divisions—the first, second, third, and ascending frontal convolutions; the *parietal*, with its four sub-divisions—the ascending, superior, supra-marginal, and angular convolutions; the *occipital*, with its three convolutions—only the first and second appearing.

The figured and lettered circles are the cortical areas, mapped out on the surface, corresponding to various centers which have been located by the experiments and observations of Farrier and others.

The motor areas in general are in close relation to the fissure of Rolando, especially in the ascending frontal and parietal convolutions.

(1)—On superior parietal lobule: centers for advancing opposite leg and foot, as in walking.

(2, 3, 4)—Around upper end of fissure of Rolando: centers for complex movements of arms, legs and trunk combined, as in climbing and swimming.

(a, b, c, d)—On the ascending parietal convolutions: the centers for fingers and wrist—prehensible.

(5)—Posterior end of first frontal convolution: for reaching out the arm and hand.

(6)—On the ascending frontal: for flexing and supinating fore arm and hand—especially for the biceps.

(7, 8)—Middle of same convolution: for elevation and depression of the angle of the mouth.

(9, 10)——Broca's convolution—the *aphasiac* region: for movements of lip and tongue.

(11)—Between (10) and lower end of the ascending parietal: retraction of angle of mouth—the *platysma.*

(12)—Posterior parts of first and second frontal convolutions: for lateral movements of head and eyes, elevation of eyelids and dilatation of pupil.

(13, 13')—Supra-marginal and angular convolutions: centers of vision, with which the occipital lobe is also concerned.

(14)—On superior tempero-sphenoidal: for center of hearing.

The center for smell is in the *hippocampal* lobule, not shown on the surface. Near by is the center of taste.

The center for sense of touch is in the hippocampal region and *gyrusfornicatus.*

CRANIO-CEREBRAL TOPOGRAPHY — LANDMARKS AND RULES FOR LOCATING ON THE SKULL OF THE LIVING SUBJECT, THE POSITION OF THE LOBES, PRINCIPAL BLOOD-VESSELS, FISSURES AND CONVOLUTIONS OF THE BRAIN.

(L)—Lower border of orbit.

(E)—External angular process.

(T)—Beginning of temporal ridge.

(S)—Supra-orbital notch.

(G)—Glabella—prominence just above root of nose.

(B)—Bregma—junction of inter-parietal and fronto-parietal sutures.

(-|-)—Center of parietal protuberance.

(O)—Occipital protuberance.

(M)—Posterior border of mastoid process.

(D)—Depression in front of external auditory meatus.

(HL)—Horizontal base line from lower border of orbit through middle of meatus to the occiput. Plain lines indicate position of primary fissures. Dotted lines, the secondary fissures or sulci.

(a, b)—Imaginary lines which arbitrarily mark the division between the parieto-occipital and temporo-sphenoidal lobes.

The *longitudinal fissure* corresponds to the curved line (G O) and separates the hemispheres of the cerebrum.

The *transverse fissure* (OD) is represented by a line from the occipital protuberance to the meatus and corresponds to the superior curved line of the occipital bone, marking the separation of the occipital lobe from the cerebellum by the tentorium.

The *fissure of Sylvius* is indicated by a line starting one and one-fourth inches behind the external angular process of the frontal bone (E) and ending three-fourths of an inch below the center of

the parietal protuberance (†). The first three-fourths of an inch is the main fissure at the end of which it divides into the ascending branch, which extends upward an inch from the horizontal branch just given. The division is beneath the anterior inferior angle of the parietal bone. The motor speech center is just in front of the vertical branch of this fissure.

The *fissure of Rolando.* Draw the lines from (D) to the bregma (B) and from (M) to (F). Perpendicular to the base line (HL). (F) can also be located by taking fifty-five and seven-tenths per cent. of the distance from (G) to (O). The fissure is represented by a line from (F) to the intersection of the fissure of Sylvius with the perpendicular line (DB).

The *parieto-occipital fissure* is an inch long and at right angles to the longitudinal fissure. It is one-fourth of an inch in front of the junction of the lambdoidal and inter-parietal sutures, and is about twenty-three per cent. of the distance from (O) to (G). Also, if a line corresponding to the horizontal branch of the fissure of Sylvius were extended to the longitudinal fissure, the last inch would represent the parieto-occipital fissure.

These primary fissures divide the outer surface of the hemisphere into its four principal lobes, as follows: The *frontal lobe*, which is limited behind by the fissure of Rolando, and occupies the anterior fossae of the bones of the skull. It has on its surface three secondary fissures or sulci. The *first frontal fissure* is parallel with the longitudinal fis-

sure, and midway between it and the temporal ridge beginning at the supra-orbital notch (S). The *second frontal fissure* is approximately represented by the temporal ridge on the frontal bone. The *precentral fissure* begins just above the upper end of the vertical branch of the fissure of Sylvius and extends half way to the longitudinal fissure. It lies beneath the fronto-parietal suture, or just behind it. The frontal convolutions are found between these various fissures.

The *parietal lobe* is limited, in part, by the fissure of Rolando in front and the parieto-occipital fissure behind. Of its four convolutions, the *ascending parietal* lies behind, and parallel with, the fissure of Rolando; the *supra-marginal*, around the upper end of the horizontal branch of the fissure of Sylvius; beneath the parietal eminence, and a little below it, the perpendicular line (M F) separates it from the *angular convolution.*

The *inter-parietal fissure* is nearly indicated by a line starting on the fissure of Sylvius, three-fourths of an inch behind the fissure of Rolando, running parallel with the longitudinal fissure, passing within one-half inch of the other end of the parieto-occipital fissure.

The *occipital lobe* is limited above by the parieto-occipital fissure extended as the curved line (a) to the end of the fissure of Sylvius. It is arbitrarily limited in front by the line (C) (b).

The *temporo-sphenoidal lobe* lies in the middle fossae of the skull and is bounded above by the fissure of Sylvius, its lower border corresponding to

the zygoma, and a line continuing it to the superior curved line of the occipital bone. Its anterior limit is the posterior superior border of the malar bone. It is about one and five-eighths inches wide at the meatus.

The *first temporo-sphenoidal fissure* is parallel with the fissure of Sylvius and an inch below it.

The *second temporo-sphenoidal fissure* is three-fourths of an inch below, and parallel with, the first.

The posterior limit of the *optic thalamus* corresponds to the perpendicular line (MF).

The anterior limit of the *corpus striatum* is a little in front of a vertical line from the beginning of the fissure of Sylvius.

Of the fifteen cerebral venous sinuses only two are in such relations to the skull as to be of practical importance in trephining for traumatic or pathological conditions.

One is the *longitudinal sinus* which corresponds to the curved line (G) (O), but it is slightly to the left of the median line and increases in width from before backwards. The other is the *lateral sinus*, which is indicated by the line from (O) to the auditory meatus and corresponds to the superior curved line of the occipital bone. It marks the inner surface of the tip of the posterior-inferior angle of the parietal bone. Hemorrhage from these sinuses is a serious complication of wounds, either operative or accidental, but on account of the low blood pressure in them is easily arrested by light pressure or fine cat-gut suture—

the latter being difficult to apply in the midst of a free bleeding.

The *middle Meningeal* artery is the chief supply of the skull and dura mater and is the only artery to be avoided in operations on the skull. The only part of it likely to be wounded is its main branch which corresponds to the middle of the anterior-inferior angle of the parietal bone, ascending behind but nearly parallel with the fronto-parietal suture. The next large branch is horizontal and corresponds nearly with the second tempero-sphenoidal fissure (which see). Hemorrhage from these branches is annoying, but usually not serious, as it can generally be arrested by the usual means—forci-pressure is often the best means. Still they are to be avoided in operations, when possible.

THE EYE.

The organ of vision consists of the Globe and its protective organs, as the Eyelids and the Lachrymal Apparatus.

The eyelids are two elliptical structures consisting of strata of different tissues. The strata are :

I. The *skin.*

II. The *orbicularis muscle,* (4) which closes the lids, is of thin pale fibres, and supplied by the facial nerve as one of the muscles of expression. A thicker part of this muscle surrounds the borders of the orbit.

III. The *tarsal cartilage,* which is a rigid

plate of connective tissue held in place by the tarsal ligaments, which extend from their outer border to the periosteum of the orbit, and which prevent pus, in suppuration of the lid, from passing back into the orbit.

IV. The expanded tendon of the *levator palpebrae* (upper lid only).

V. *Meibomian* (*sebaceous*) *glands*, (2) whose ducts open on the free margins of the lid, (3) the fatty secretion of which prevents the overflow of tears.

VI. *Mucous membrane* (*conjunctiva*), which secretes some mucus, but mostly tears.

The eyelids contain no fat, but the different strata are held together by delicate areolar tissue. The upper lid is the larger and more movable. The interval between the two lids is the *palpebral fissure*. The junction of the lids, at the ends of the fissure, makes the *inner canthus* and the *outer canthus*. Near the inner canthus, each lid has a papilla, in which is a small opening to receive tears, the *punctum lachrymale* (5).

The tear apparatus consists of the *lachrymal gland* (1) situated below the external angular process of the frontal bone, and whose excretory ducts (eight to ten) perforate the conjunctiva on the under surface of the upper lid; the *puncta* (5) which are the outer openings of the *canaliculi* (6) (upper and lower), which join to form the *lachrymal sac*, from which passes downwards (7) the *nasal duct*, opening into the *inferior meatus* of the nose, towards the front. The upper canaliculus first as-

cends vertically, dilates into a small pouch, and then runs, a quarter of an inch, transversely. The lower descends vertically, at first, and is shorter and thicker. The nasal duct is three-fourths of an inch in length, and is directed downward, backward and slightly outward.

The globe is held in its place in the orbit, chiefly, by the four *recti* muscles (8), which, with the two *oblique*, move it on its posterior cushion of fat, as a ball and socket joint.

(9). Junction of *cornea* with (10) *sclerotic*, which, posteriorly, is continuous with the fibrous covering of the optic nerve derived from the dura mater.

(11). *Iris*, which contains two muscles—the circular (*sphincter*), which surrounds the pupil, lying near the posterior surface, and is supplied by the third nerve; and the radiating muscle (*dilator*), which is chiefly supplied by the sympathetic. The iris is suspended in the fluid (*aqueous humor*) which fills the space between the cornea and the *lens*. The space in front, the anterior chamber, connects through the pupil with the posterior chamber.

(12). *Ciliary processes*, radiating folds of the *choroid* (13) sixty or seventy in number. The *ciliary muscle* (muscle of accommodation) is a ring of unstriped fibres placed at junction of iris and choroid, between the ciliary processes and the sclerotic.

(14). The *retina*, the expansion of (15) the *optic nerve*.

THE EAR.

The organ of hearing consists of the outer cartilaginous part, the Pinna; the External Auditory Meatus; the Tympanum or Middle Ear; and the Labyrinth or Internal Ear, comprising the Vestibule, Cochlea, and Semi-circular Canals. The *pinna* is composed of yellow fibro-cartilage, and has a tubular prolongation inwards to form a part of the meatus.

(1).—A sectional view of the bony part of the external auditory meatus. The whole canal is one inch and a quarter in length, the cartilaginous portion forming a little less than one-third. The narrowest part of the canal is about its middle. Hence the difficulty of extracting foreign bodies which get beyond this constriction. The direction of the canal is, at first, inward, forward, and upward; then it curves slightly downward. The floor is a little longer than the roof, owing to the tympanic membrane being placed obliquely.

(2).—The *membrana tympani*, a thin, semi-transparent, membranous disc, slightly oval in shape, forming a complete partition between the external auditory canal and the middle ear. It has a thin layer of true skin on its outer surface. Its inner surface is lined with the mucous membrane of the tympanum. It is supplied with sensation, in connection with the auditory canal, by a branch from the auriculo-temporal of the third division of the trifacial.

(3).—Inner surface of membrana tympani,

against the upper half of which lies, vertically, the handle of the *malleus* (4).

(5).—The *incus* or anvil bone.

(6).—The *stapes*, or stirrup bone, he base of which is attached to the membrane of the *fenestra ovalis* on the inner wall of the cavity of the tympanum. From the anterior wall of this cavity the *Eustachian tube* leads downward, forward and inward to the pharynx. On the posterior wall are three or four openings which convey air to the mastoid cells.

The internal ear consists of (7) the three semicircular canals behind; in front, (8) the cochlea; and the vestibule, a small cavity placed between (7) and (8).

(9).—Termination of the auditory nerve in the cochlea.

The cochlea is in the form of a snail shell. Its base, one-fourth of an inch in diameter, corresponds to the bottom of the internal auditory meatus—the apex being directed outward and forward.

The auditory nerve, the portio mollis of the seventh pair, after passing down through the internal auditory meatus, divides into two sets of branches, the anterior being distributed in the cochlea, the posterior in the vestibule.

PART SECOND.

THE MALE AND FEMALE GENERATIVE ORGANS —THE FOETAL CIRCULATION.

BY

J. SUYDAM KNOX, A. M., M. D.
PROFESSOR OF OBSTETRICS AND DISEASES OF CHILDREN,
RUSH MEDICAL COLLEGE,
CONSULTING OBSTETRICIAN, PRESBYTERIAN HOSPITAL,
CHICAGO.

THE MALE GENERATIVE ORGANS.

INDEX TO SECTIONS.

(1)—Peritoneum.
(2)—Bladder, Exterior, (2′) Mucous Coat, (2″) Muscular Coat.
(3)—Symphysis Pubis.
(4)—Prostate Gland, (4′) Section of
(5)—Vesiculæ Seminalis, and Vas Deferens.
(6)—Rectum, External Coat.
(7)—Glans Penis.
(8)—Penis, (8′) Section of
(9)—Corpus Cavernosum.
(10)—Corpus Cavernosum, Section of
(11)—Membranous portion Urethra.
(12)—Bulb of Urethra.
(13)—Cowper's Gland.
(14)—Spermatic Vein.
(15)—Spermatic Artery.
(16)—Vas Deferens.
(17)—Ureter.
(18)—Spermatic Cord.
(19)—Vertebra.
(20)—Testicle.
(21)—Epididymis.
(22)—Spermatic Artery.
(23)—Spermatic Vein.

(24)—Major globe of Epididymis.
(25)—Internal texture of Testis.
(26)—Structure of Corpus Cavernosum.
(27)—Artery of Corpus Cavernosum.
(28)—Dorsal Artery of Penis.
(29)—Orifice of Ureter.
(30)—Vas Deferens.
(31)—Epididymis.
(32)—Rete Testis.
(33)—Globus Major Epididymis.
(34)—Seminal lobules of Testis.
(35)—Fossa Navicularis Urethræ.
(36)—Corpus Spongiosum.
(37)—Corpus Spongiosum.
(38)—Membranous Urethra.
(39)—Prostatic Urethra.

MALE GENERATIVE ORGANS.

These consist of the *penis* and *testes* and their appendages. The *penis* (8) is the organ of copulation. It consists of a *body* (8) and *glans* (7).

The *body*, at its base, is firmly connected to the rami pubis by fibrous crura, and to the symphysis pubis (3) by a suspensory ligament.

The *glans penis* (7) is cone-shaped. A vertical fissure, at its summit, is the orifice of the *urethra*, called *meatus urinarius*. The base of the glans is a rounded ridge (*corona glandis*) and behind this ridge a deep depression, (*cervix*). Buried in this depression are numerous sebaceous glands, secreting an odorous matter. Want of cleanliness

causes an accumulation of this secretion, with irritation. The mucous membrane covering the glans penis contains no sebaceous glands, but has on its surface a number of very sensitive papillæ.

The body of the penis, when flaccid, is cylindrical; when erected, triangular. It is composed of a mass of erectile tissue (26) enclosed in three cylindrical, fibrous compartments. Two of these, the *corpora cavernosa* (9), lying side by side, form the upper part of the penis. The third, the *corpus spongiosum* (36), encloses the urethra and forms the under portion of the penis.

The corpora cavernosa consist of a very firm, highly elastic, fibrous envelope, which contains meshes of fibrous and erectile tissue (10). The union of the corpora forms a groove above, in which run the dorsal vessels (28) of the penis, and a deeper groove below, in which lies the corpus spongiosum enclosing the urethra. The arteries of the corpora cavernosa (27) are derived from the *pudic*. They terminate in curling, dilated extremities, (*helicine*), which allows them to accommodate themselves to the erection of the organ without stretching.

The corpus spongiosum receives its arterial supply from the *internal pudic*. The upper portion of the penis can thus be erected without the lower.

The penis is supplied with lymphatics. Its nerves are derived from the *internal pudic* and *hypogastric plexus*.

The cutaneous covering of the penis is extremely elastic, like that of the scrotum. It is finer

and of darker color than that of surrounding parts. It is attached loosely to the penis by a connective tissue which contains no fat, and therefore allows of great motion.

It is possible, in performing circumcision, to draw the foreskin so far forward as to cut off the whole skin covering the penis. It is therefore necessary to mark the line of incision before drawing forward the foreskin.

The *urethra* (36, 38, 39) is the canal for the discharge of the urine and the semen. It is eight or nine inches long, and extends from the bladder (2) to the fissure of the glans penis (7). From the latter its direction is practically straight until it reaches the membranous portion (38), when it begins to curve upward and forward to enter the bladder. Inflexible catheters and sounds are made to imitate and accommodate this curve.

Anatomically, the canal of the urethra is divided into three portions, the *spongy* (36), the *membranous* (38), and the *prostatic* (39).

Gonorrheal inflammation, at times, invades the glandular structures of the prostate, establishing a most intractable disease.

The *testicle* (20) is the organ of seminal secretion. It lies in a special cavity called the scrotum, suspended by a collection of structures called the spermatic cord (18).

The *scrotum* consists of three layers, namely, the *skin*, the *tunica fibrosa*, and the *tunica vaginalis*. The scrotum contains two cavities—a right and left—each containing a testicle, and each communi-

cating with the abdominal cavity through the *inguinal canal* (18). The nerves and blood-vessels of the testicle pass through this canal and constitute the spermatic cord. The cavity of the scrotum, which is a serous cavity, may be filled and distended with fluid, as a result of inflammation, causing *hydrocele.* Through the inguinal canal also a loop of intestine may descend, producing *inguinal hernia.*

The *testicles* (20) are two in number, a right and left. The left hangs lower than the right to prevent injury when the thighs are brought together. During foetal life the testicles lie just below the kidneys, and gradually descend to the inguinal canal as pregnancy advances to term. At birth, the testicles should be found in the scrotum. At times, one, and more rarely, both remain in the abdominal cavity. Where both are retained, sterility generally exists. Absence of the testicles (*anorchus*) occurs, rarely, and produces impotence. The testicles often become diseased, requiring removal. This operation is called *castration,* and when performed on both sides, unsexes the patient and causes impotence. The testicle is covered with a fibrous capsule (20) (*tunica albuginea*), and contains a glandular secreting substance (34) and vessels (25) and nerves.

The fibrous capsule of the testicle is covered by the *tunica vaginalis,* which is adherent to it, and also invests and binds to the testicle the *epididymis.* Beneath the tunica albuginea is a fine network of blood-vessels (*tunica vasculosa*) which supplies the secreting substance.

Prolongations inward of the tunica albuginea, called *septa*, divide the substance of the testes into lobules. These lobules, 200 or 300 in number, consist of two or three convoluted seminal tubes of a diameter of 1-200 of an inch. Each lobule is enclosed in a delicate plexus of blood vessels. At the apices of the lobules the seminal tubes become straight and pass upwards, freely anastomosing, finally terminating in 15 or 20 ducts (32). These ducts perforate the tunica albuginea, carrying the seminal fluid from the testes to the epididymis (33). Here they enlarge and become very much convoluted (33). They then descend downward (31) to the base of the testicle, where, by union, they become one tube, the *vas deferens* (30).

Inflammation of the epididymis leads to temporary or permanent obliteration of the vas deferens, causing temporary or permanent sterility. The vas deferens is thus the final outlet of the secretion of the testes. Commencing at the lower part of the epididymis, it ascends along its posterior side (30) and along the back part of the spermatic cord, until it reaches the inguinal canal (16). Entering the pelvic cavity, it descends along the side of the bladder (2), passing downward and backward towards its base. At the base of the bladder, it lies between that organ and the rectum. (6). In this position it becomes enlarged and sacculated (5) until it reaches the base of the *prostate* (4), where it narrows and unites with the *vesicula seminalis* (5) to form the ejaculatory duct. These

ducts run forward through the prostate to discharge the semen into the urethra (38).

The *seminal vesicles* (5) are two sacculated pouches lying on each side of the base of the bladder, just outside of the vasa deferentia. They act as seminal reservoirs. They may be felt by examination through the rectum.

The blood-vessels of the spermatic cord are the *spermatic* (22), *deferential* and *cremasteric arteries*, and the *spermatic veins* (23). The spermatic veins form a plexus of vessels, and make the chief mass of the cord. They often become varicosed, forming what is called *varicocele*.

The *semen* is a complex fluid, consisting of secretions from the testes, prostate, seminal vesicles and Cowper's gland. Examined under the microscope, it is found to contain numerous filaments possessing rapid undulatory movements. These are called *spermatozoa*. They are the impregnating agents of the semen. Absence of them in the seminal fluid indicates sterility.

Acids arrest the movements of the spermatozoa. Alkaline solutions stimulate their motion. Acrid vaginal discharges may thus be a cause of barrenness. Menstrual blood and alkaline mucus discharges from the womb prolong their vitality. For this reason they have been found in motion a week after coitus.

THE FEMALE GENERATIVE ORGANS.

INDEX TO SECTIONS.

(A)—Meatus Urinarius.
(B)—Labia Minora.
(C)—Vagina.
(D)—Venous Plexus of Bulb.
(E)—Glands of Deverney.
(F)—Anus.
(G)—Clitoris.
(K)—Fimbria attached to Ovary.
(L)—Fimbriae of Fallopian Tube.
(M)—Hymen.
(N)—Ligament of Ovary.
(O)—Ovary, (O')—Section of
(P)—Peritoneum.
(Q)—Ascending Colon.
(R)—Rectum.
(S)—Sigmoid Flexure.
(T)—Descending Colon.
(U)—Uterus.
(V)—Pampiniform Plexus.
(W)—Venous Plexus of Uterus.
(X)—Parovarium.
(Y)—Internal Os Uteri.
(Z)—Arbor Vitae of Cervix.
(A')—Urethra.

(Bl)—Bladder.
(F T)—Fallopian Tube.
(F T′)—Fallopian Tube.
(U′)—Cavity of Uterus.
(a)—Decidua Vera.
(b)—Decidua Reflexa.
(c)—Chorion.
(d)—Amnion.
(e)—Foetus.
(f)—Umbilical Cord.
(g)—Placenta.
(h)—Uterine Sinuses.
(i)—Mesentery.
(k)—Ileum.
(l)—Ileo-Caecal Valve.
(m)—Ascending Colon.
(n)—Caecum.
(o)—Orifice Vermiform Appendix.
(p)—Vermiform Appendix.
(1)—Dorsal Vein of Clitoris.
(2)—Veins of communication.
(3)—Isthmus of Bulb and Veins.
(4)—Bulb of Vagina and Veins.
(5)—Superficial Perineal Vein.
(6)—Pudic Veins.
(7)—Pudic Veins.
(8)—Pudic Veins.
(9)—Pudic Artery.
(10)—Transversus Perinei Artery.
(11)—Artery of Bulb.
(12)—Profunda Artery of Clitoris.
(13)—Profunda Artery of Clitoris.

(14) Pudic Nerve.
(15) Pudic Nerve.
(16) Pudic Nerve.
(17) Crus Clitoris.
(18) Muscles of Crura.
(19) Transversus Perinei Muscle.
(20) Superficial Sphincter Ani.
(21) Bulbo Cavernosus Muscle.
(22) Perineal Fascia.
(23) Tuberosity of Ischium.
(24) Symphysis Pubis.
(25) Poupart's Ligament.
(26) Superior Spine of Ilium.
(27) Obturator Membrane.

FEMALE GENERATIVE ORGANS.

The female generative organs are divided into two groups: the *external* and the *internal.*

The external generative organs are called the *pudenda* (pudere—to be ashamed), and comprise: the *mons veneris, labia majora, labia minora* (B), *clitoris* (G), and *hymen* (M). These form the *vulva* or orifice of the vagina.

The internal organs comprise: the *vagina* (C), *uterus* (U), *Fallopian tubes* (F T) and *ovaries* (O).

EXTERNAL GENITAL ORGANS.

The *mons veneris* is a fatty cushion covered with hair after puberty, containing sebaceous glands, resting upon the symphysis pubis. It is the base of the external abdomen and the upper and anterior junction of the labia majora.

The *labia majora* (N) are two longitudinal tegumentary folds, rounded and slightly curved. They bound the orifice of the vagina on each side, and act as a sort of valve closing it—whence the term vulva. Their superficial surface is true skin sparsely covered with hair. Their inner surface is mucous membrane, but contains sebaceous instead of mucous glands.

The shape and size of the labia majora vary with age. In the young virgin they are rounded and firm, completely closing the vaginal orifice. In married women, who have borne children, they are less rounded and gape apart. In old age they are shrunken and wasted.

The *labia minora* (B) are two membranous folds of a shell pink color, situated between the labia majora. Their outer surface is continuous with the labia majora and their inner surface with the mucous membrane of the vagina (C). They are also called *nymphae*, (goddesses of the fountain), because they were supposed to direct the stream of urine.

Superiorly, each labium splits into two folds, one of which passes over, the other under, the *clitoris* (G) to unite with the corresponding folds of the opposite side. Thus are formed the *praepuce* and *frenulum* of the clitoris. Below, the labia minora pass around the orifice of the vagina, and unite to form the *frenulum vulvae*, or *fourchette*.

The *clitoris* (G) is a small, elongated, spongy body, lying below the upper junction of the labia majora (N). It is hung from the *symphysis pubis*

(24) by a suspensory ligament, and protrudes from the folds of the labia minora (B). It resembles the penis in possessing crura, corpus and glans, lacking, however, corpus spongiosum and urethra.

The crura (17) are long, slender processes, of spindle shape, attached to the rami of the pubes (24), uniting to form the corpus or body. The extremity of the body is the glans (G), of a pale red color, and covered with papillae. These contain nerve endings of extreme sensitiveness.

In a state of erection, the clitoris measures less than an inch in length. This erection of the clitoris occurs from emotional or mechanical excitement, and is due to the filling of its spongy body with blood from its appropriate vessels (1), (12), (13).

The *meatus urethrae* (A) is situated about three-quarters of an inch vertically below the clitoris (G). It is the lower boundary of the *vestibulum*, which is a space, bounded by the clitoris (G) above, the labia minora (B) at the sides, and the vaginal orifice below (C). The meatus is surrounded by a sphincter muscle, which puckers the mucous membrane and serves as a guide for the introduction of a catheter. The urethra is larger and shorter in women than in men, and can easily be dilated for the introduction of the finger into the bladder.

The *Hymen* (M).—In virgins the anterior extremity of the vagina is closed by a double fold of mucous membrane called the hymen. The inner surface is a continuation of the mucous lining of the

vagina (C); the outer, that of the labia minora (B); between these layers of mucous membrane are some connective tissue, muscular fibres and blood vessels. The hymen is usually crescentic in shape, its concave border looking upward. There are, however, other forms, viz.:

1. Hymen cribriformis, with a number of small openings.

2. Hymen annularis, where it is like a ring, with the opening in the center.

3. Hymen imperforatus, when there is no opening at all, and menstrual blood is retained after puberty, requiring surgical interference.

4. Hymen fimbriatus, where it looks as if the virgin had been deflowered and the hymen torn. At times, there is no hymen at all; and, again, the hymen may be so distensible that coitus can take place and it be not ruptured. Absence of hymen is therefore no positive sign of coitus, and its presence no sure proof of chastity; while the hymen fimbriatus resembles, but is no proof of, laceration from intercourse.

INTERNAL ORGANS OF GENERATION.

The *vagina* (C) is the canal which connects the uterus with the external genital organs. Its walls are composed of mucous membrane, connective, elastic and muscular tissue, and in its upper portion, posteriorly, peritoneum. Unless artificially distended, its anterior and posterior walls lie in contact. The anterior wall is nearly an inch shorter than the posterior one, whose length is

about three and a half inches. The vagina lies between the bladder (Bl) and the rectum (R) and is closely united to them, forming the *recto-vaginal* and *vesico-vaginal septa.* The upper fifth of the posterior wall is separated from the rectum by a fold of peritoneum, called Douglas' cul-de-sac. This is the only point where the abdominal cavity can be entered from the vagina. This is often taken advantage of to drain the abdominal cavity after laparotomies. The upper part of the vagina encircling the cervix uteri, and attached to it, is called the *fornix.*

The mucous lining of the fornix is comparatively smooth. As the canal, however, is descended, the walls thicken, particularly on the anterior and posterior aspects, throwing the mucous membrane into folds, and forming the anterior and posterior vaginal columns. The mucous membrane of the vagina is also covered with vascular papillae and contains scattered mucous follicles, which keep its surface constantly moist with an acid mucus.

The vagina receives its blood supply from the *hypogastric,* the *vesical,* the *uterine,* and the *pudendal* arteries, and returns the blood through the corresponding veins, which form a close plexus around it. As these veins have no valves, and anastomose freely with the veins of other pelvic organs, it can readily be seen that any disturbance of return circulation will impart a purplish color to the vagina, and it will be congested, by the congestion of any other pelvic organ. Thus when pregnancy causes descent of the womb and disturbance of its return

circulation, the vagina also becomes congested and its purplish color becomes one of the signs of pregnancy. In the same way congestion of the rectum, causing piles, will also congest the vagina and cause excessive mucous secretion termed *leucorrhoea* or whites.

The *uterus* (U) is the organ that contains, nourishes, and finally expels the foetus. In the virgin it resembles an inverted wide-necked flask. It is about two and one-half inches in length, and is divided by a well marked contraction into two nearly equal parts. The upper half is called the *body*, the lower the *cervix*. The body is egg-shaped, but flattened in front. The cervix is cylindrical, with a rounded lower extremity. This is surrounded by, and protrudes into, the vagina. It possesses an oval aperture, leading to the cavity of the womb. This opening is called the external os, or *os tincae* from its supposed resemblance to the mouth of the Tench.

Maternity changes permanently the uterus. The body becomes rounder and larger, proportionately, than the cervix. The cervix becomes broader and less firm at its apex, and the external os, on account of lacerations of its border during labor, becomes a ragged slit.

On making a lateral section of the uterus, its cavity (U′) is opened. This is found to be triangular in shape, with convex sides.

The base of the triangle is the *fundus*.

At the two angles of the base are found the fine openings (the size of a bristle) leading into the

Fallopian tubes (F T'). The apex of the triangle is the *internal os*, a round orifice sufficiently large to admit a uterine sound.

The canal of the cervix (Z), which lies between the internal and external os, is spindle shaped. Its inner surface, like the vagina, possesses an anterior and posterior ridge, called *arbor vitae* (Z), from its resemblance to the leaves of that tree.

The position of the uterus in the pelvis, and its attachments, allow it great freedom of motion

Its lower extremity projects into the vagina, its anterior surface is attached to the bladder (Bl). The fundus is covered by the peritoneum (P) which descends over the body of the uterus front and rear. These folds of peritoneum meet at the sides, covering the Fallopian tubes (F T), ovaries (O), blood vessels and nerves, and are called the broad ligaments. They divide the cavity of the pelvis into two nearly equal halves. In operations for the removal of the uterus, these ligaments must be carefully ligated before section.

Two other folds of peritoneum, carrying with them muscular fibres from the uterus, pass backward on each side of the rectum to the sacrum, and form the *sacro-uterine* ligaments. Two more peritoneal folds, also carrying muscular uterine fibres, pass forward on each side of the bladder to the inguinal canals, and are called the round ligaments of the uterus. Cutting down on the inguinal canal, and drawing out and shortening these round ligaments, is called Alexander's operation. This operation corrects retroversion of the uterus.

The six ligaments thus holding the uterus in position allow of much extension; so that for surgical procedures the cervix can be drawn almost to the mouth of the vagina.

Relaxation of these ligaments causes the various displacements of the womb.

The muscular tissue of the womb, which consists of three layers, is of the unstriped variety and, therefore, involuntary in its action.

The mucous membrane of the body of the uterus is soft and smooth. It is filled with glands which secrete an alkaline mucus. Between these glands is an abundant capillary network of blood vessels, which is the source of the menstrual hemorrhage.

The mucous lining of the cervix is yellowish-red in color, firm and ridged, and can readily be distinguished from the smooth red lining of the body. Its glands secrete an abundant, glairy white mucus —like the white of an egg. This mucus, in chronic catarrhal inflammation of the membrane, often causes sterility by closing the cervical canal to the spermatozoa.

The *Fallopian tubes* (F T) are practically continuations of the uterus. Their cavity (F T′) communicates directly with the uterine cavity, and their mucous lining and muscular tissue proceed from the latter organ. These tubes are from three to four inches long. As they proceed from the uterus, their canal is straight and narrow, but it soon becomes sinuous and enlarged, and terminates in a fringed (fimbriated) extremity (L). One fimbria, longer than the others, is attached to the outer

border of the ovary (K). During ovulation the fimbriae apply themselves to the ovary, and establish a continuous canal to the uterus for the conveyance of the spermatozoa and the passage of the ovum.

The muscular walls of the tubes are of involuntary fibre and have a peristaltic movement.

The *ovaries* (O), two in number, are the analogues of the testes of the male. They lie in the broad ligaments, directly below the Fallopian tubes (F T). They are ovoid in shape, about one inch long, three-fourths of an inch wide, and a half inch thick. Each ovary is attached to the uterus by a ligament (N) about an inch long, and at its opposite extremity to one of the fimbriae of the Fallopian tube (K). On section, the ovary (O′) is found to contain within its tunic a central, red, medullary substance, and a surrounding grey cortical substance. The granular appearance of this cortical substance is due to a vast number of vesicles called Graafian, after their discoverer. Each vesicle contains an ovum which is susceptible, on maturity, of impregnation and of subsequent development, in the uterus, into a foetus.

Blood-Vessels of Uterus and its Appendages.

Arteries: 1. *Arteria uterina hypogastrica.*—This arises from the hypogastric. It descends downward to reach the vagina, then bends upward between the folds of the broad ligament and pursues a tortuous course along the sides of the uterus.

2. *Arteria uterina aortica.*—This artery springs from the aorta about two and a half inches above

its bifurcation. It descends to the pelvis with many a spiral curve, and then ascends between the folds of the broad ligament to supply the fundus of the uterus, Fallopian tubes and ovaries.

These two arteries communicate freely.

The circumflex branch uniting the arteries of each side, and placed around the location of the internal os, is of surgical interest, as it may be wounded in lacerations of the cervix, or in operations therefor. The blood flows from two plexes of veins, viz.:

1. *Plexus uterinus* (W).
2. *Plexus pampiniformis* (V).

These form a close net-work of veins about the uterus, Fallopian tubes and ovaries. The first empties into the hypogastric, and the second the spermatic vein.

The uterus also contains an abundant supply of lymphatics and of nerves of sympathetic origin.

Development of the Ovum.

The fecundation of the ovum takes place at the surface of the ovary (O), or in the Fallopian tube (F T). It consumes a week in reaching the cavity of the womb (U′). During this time the uterine mucous membrane has become congested and thrown into folds (a), within one of which the impregnated ovum is soon entangled and attached. As soon as the ovum has thus secured a lodgement, the uterine mucous membrane begins to enclose it, forming a complete envelope about it, called *decidua reflexa* (b). The ovum enters the uterine cavity enclosed

in its *vitelline membrane*, and the *blastodermic membrane*, resulting from fecundation; subsequently the *allantois* spreads itself over the whole interior of the globe of the ovum, carrying with it the blood-vessels of the growing foetus. At this stage of development, the embryo (e) is enclosed in the *decidua* (b) derived from the mucous lining of the womb, and the *chorion* (c), (made up of the vitelline membrane, the blastodermic membrane and the allantois). Simultaneously, a third membrane is developed called the *amnion* (d), which directly envelopes the embryo, floating in a fluid called amniotic.

As was said before, the allantois (part of the chorion) carries with it the blood-vessels of the embryo. These penetrate the chorion and enter the decidua, coming in contact with, but not mingling with, the maternal blood. This development of blood-vessels on the surface of the chorion makes it *shaggy* (c) in appearance. As the development of the embryo progresses, these blood-vessels disappear from the chorion, except at the point where the decidua lies upon the uterine tissue (c). This becomes the site for the future development of the placenta (g).

The *placenta* (g) is the organ of respiration, nutrition and excretion of the foetus. After the allantois has spread over the entire inner surface of the ovum, it extends its villi into the decidua, so that nutrition is absorbed by the embryo from the whole surface of the chorion. With the enlargement, however, of the ovum, the decidua reflexa

becomes thinned, with an obliteration of its vessels and a corresponding disappearance of the villi of the chorion. Thus, the whole process of exchange between mother and foetus, becomes concentrated in the *decidua scrotina* (h). This is the site and origin of the *placenta.* The villi of the chorion here wonderfully multiply and branch out, each villosity being followed and surrounded by a corresponding development of maternal vessels. The placenta (g) may then be defined as a mass of connective and vascular tissue representing the site of contact of the maternal and foetal circulations.

The pedicle of the allantois becomes the *umbilical cord* (f). It consists of two arteries (16) and one vein (18) embedded in a gelatinous substance and enclosed in the amnion.

During the ninth month of gestation, the tissue connecting the placenta with the uterine wall undergoes fatty degeneration, so that, at term, it is easily separated.

On separation, the uterine muscular tissue is laid bare and its blood-vessels torn.

The *foetal circulation* is entirely independent of that of the mother. At no time do the vessels of mother and child communicate directly with each other. Thus, a woman dying in labor, from hemorrhage, can bring forth a vigorous babe. The force maintaining the current of foetal circulation is the foetal heart. The peculiarities of the foetal circulation are :

1. The blood does not go to the lungs for the

interchange of oxygen and carbonic acid, but to the placenta.

2. A special arrangement of vessels to accomplish this, viz.: *umbilical cord*, (one vein and two arteries), *ductus venosus*, *foramen ovale*, and *ductus arteriosus*.

Starting at the placenta, the red arterial blood flows through the umbilical vein (18) to the navel (17) of the foetus, and then upwards (27) to the liver (24). Here it mingles with the blood of the portal vein and enters the ascending vena cava (31) through the ductus venosus (29). Entering the right auricle of the heart, much of it passes through the foramen ovale directly into the left auricle, the balance passing into the right ventricle and mingling with the blood from the descending vena cava. That portion which passed into the left auricle goes on to the left ventricle and is forced into the aorta. That portion which entered the right ventricle is forced into the pulmonary artery, but instead of entering the lungs, goes through the ductus arteriosus (9) to mingle with the blood from the left side of the heart, the upper extremities and the head. It is now impure blood. Descending the abdominal aorta, some of it proceeds to the lower extremities, but the most of it enters the hypogastric arteries (16), springing from the internal iliacs, and passes through the navel along the umbilical arteries to the placenta. It is thus seen that the umbilical arteries carry venous blood to the placenta, and arterial blood returns through the umbilical vein.

After the birth of the foetus, and the tying of the umbilical cord, the child respires, and its blood goes to the lungs instead of the placenta for the interchange of gases. The supernumerary vessels then disappear. The current stops in the umbilical vein, the ductus venosus, and the ductus arteriosus, and they soon shrivel and disappear. The foramen ovale gradually closes, and the pulmonary arteries enlarge, bringing the circulation to its final and appropriate channels.

ADDENDA.

INDEX TO SECTIONAL VIEW OF FEMALE.

1. Abdominal wall.
2. Omentum.
3. Site of Cardiac Orifice of Stomach.
4. Liver.
5. Diaphragm.
6. Suspensory ligament of Liver.
7. Stomach.
8. Spleen.
9. Pancreas.
10. Descending Colon.
11. Abdominal Aorta.
12, 13, 15, 22. Peritoneum.
14. Section of transverse Colon.
16. Pyloric extremity of Stomach.
17, 18. Mesentery.
19. Small Intestines.
20. Intestinal section at Ilio-caecal valve.
21, 29. Rectum.
23. Uterus.
24. Round Ligament.
25. Sigmoid Flexure.
26. Bladder.
27. Symphysis Pubis.
28. Vagina.

INDEX TO PLATE OF FOETAL ORGANIZATION.

1, 2. Left and right sides of Heart.
3. Left Auricle.
4. Descending Vena Cava.
5, 6, 10. Aorta.
11, 12. Left Subclavian vein.
13, 14, 15. Common, internal and external Iliacs.
16. Hypogastric arteries.
17. Navel.
18, 27. Umbilical vein.
20, 22. Chorion.
21. Amnion.
23. Placenta.
24, 25, 32. Liver.
26. Gall bladder.
29. Ductus venosus.
30. Hepatic vein.
31. Ascending Vena Cava.
33. Kidney.
34. Supra-renal capsule.